

1   **WHAT IS CLAIMED IS:**

2           1. A channel noise estimating method applied to a multi-carrier system  
3   consisting of  $K$  subchannels over which original data symbols ( $X_k[n]$ ) (where  $n$  is  
4   the discrete time index,  $k \in \{1, 2, \dots, K\}$  is the subchannel index) are transmitted in  
5   a frequency-domain from a transmitting unit to a receiving unit, the noise  
6   estimating method comprising the acts of:

7           reconstructing simulated input data symbols ( $X'_k[n]$ ) that simulate the  
8   original data symbols ( $X_k[n]$ );

9           delaying the actual received data symbols ( $R_k[n]$ ) such that the delayed  
10   actual received data symbols ( $Q_k[n]$ ) are synchronous to the simulated input data  
11   symbols ( $X'_k[n]$ );

12          calculating a channel response estimate ( $W_k[n]$ ) of one subchannel  $k$   
13   based on said delayed actual received data symbols ( $Q_k[n]$ ) and said simulated  
14   input data symbols ( $X'_k[n]$ ) according to the Least Mean Square algorithm;

15          estimating virtual received data symbols ( $Y_k[n]$ ) based on said channel  
16   response estimate ( $W_k[n]$ ) and the simulated input data symbol ( $X'_k[n]$ ); and

17          calculating a different quantity ( $e_k[n]$ ) between the delayed actual  
18   received data symbol ( $Q_k[n]$ ) and the estimated virtual received data symbols  
19   ( $Y_k[n]$ ) to represent the channel noise of said subchannel  $k$ .

20          2. The method as claimed in claim 1, in the simulated input data symbols  
21   ( $X'_k[n]$ ) reconstructing act, the original data symbols ( $X_k[n]$ ) being taken as the  
22   simulated input data symbols ( $X'_k[n]$ ) while the original data symbols ( $X_k[n]$ ) are  
23   exactly known to the receiving unit.

24          3. The method as claimed in claim 1, the simulated input data symbols

1  $(X'_k[n])$  reconstructing act further having:

2 de-mapping and decoding the actual received data symbols  $(R_k[n])$  on

3 each subchannel  $k$  to extract bit-stream data; and

4 encoding and mapping said bit-stream data to reconstruct said simulated

5 input data symbols  $(X'_k[n])$ .

6 4. The method as claimed in claim 3, wherein the simulated input data  
7 symbols  $(X'_k[n])$  reconstructing act further has a de-interleaving act after the  
8 actual received data symbols  $(R_k[n])$  de-mapping act, and an interleaving act  
9 after the bit-stream data encoding act.

10 5. The method as claimed in claim 1, in the simulated input data symbols  
11  $(X'_k[n])$  reconstructing act, said actual received data symbols  $(R[n])$  on the  
12 subchannel  $k$  being directly mapped to form the simulated input data symbol  
13  $(X'_k[n])$  for said subchannel  $k$ .

14 6. A channel noise estimating apparatus applied to a multi-carrier system  
15 consisting of  $K$  subchannels over which original data symbols  $(X_k[n])$  (where  $n$  is  
16 the discrete time index,  $k \in \{1, 2, \dots, K\}$  is the subchannel index) are transmitted in  
17 a frequency-domain from a transmitting unit to a receiving unit, the noise  
18 estimating apparatus comprising:

19 a reconstructing unit for generating simulated input data symbols  $(X'_k[n])$   
20 that simulate the original data symbols  $(X_k[n])$ ;

21 a  $D$ -tap delay line provided to delay actual received data symbols  $(R_k[n])$   
22 that are received by the receiving unit such that the delayed actual received data  
23 symbols  $(Q_k[n])$  are synchronous to the simulated input data symbols  $(X'_k[n])$ ,

24 wherein  $D$  is an integer greater than or equal to zero;

1 a channel response estimating unit, which estimates a channel response  
2 estimate ( $W_k[n]$ ) of one subchannel  $k$  based on said delayed actual received data  
3 symbols ( $Q_k[n]$ ) and said simulated input data symbols ( $X'_k[n]$ ) according to the  
4 Least Mean Square algorithm;

5 a channel noise calculating unit corresponding to said channel response  
6 estimating unit, where the channel noise calculating unit estimates virtual  
7 received data symbols ( $Y_k[n]$ ) based on said channel response estimate ( $W_k[n]$ )  
8 and the simulated input data symbol ( $X'_k[n]$ );

9 wherein the channel noise calculating unit further calculates a different  
10 quantity ( $e_k[n]$ ) between the delayed actual received data symbol ( $Q_k[n]$ ) and the  
11 estimated virtual received data symbols ( $Y_k[n]$ ) to represent the channel noise of  
12 said subchannel  $k$ .

13 7. The apparatus as claimed in claim 6, wherein while the original data  
14 symbols ( $X_k[n]$ ) are exactly known to the receiving unit, the reconstructing unit  
15 takes the original data symbols ( $X_k[n]$ ) as the simulated input data symbols  
16 ( $X'_k[n]$ ), and the actual received data symbols are directly passed through the  
17 delay line without a delaying process.

18 8. The apparatus as claimed in claim 6, wherein the reconstructing unit  
19 based on the actual received data symbols  $R_k[n]$  on each subchannel  $k$  generates  
20 simulated input data symbols ( $X'_k[n]$ ).

21 9. The apparatus as claimed in claim 8, the reconstructing unit having:  
22 a bit-stream data extractor, which de-maps and decodes the actual  
23 received data symbols  $R_k[n]$  on each subchannel  $k$  to construct the bit-stream  
24 data of the actual received data symbol; and

1           a constructor, which encodes, and maps said bit stream data to  
2   reconstruct said simulated input data symbols ( $X'_k[n]$ ) for each subchannel  $k$ .

3           10. The apparatus as claimed in claim 9, said bit-stream data extractor  
4   further including a de-interleaver, and said constructor further including an  
5   interleaver.

6           11. The apparatus as claimed in claim 8, wherein the reconstructing unit  
7   directly maps said actual received data symbols ( $R_k[n]$ ) on the subchannel  $k$  to  
8   form the simulated input data symbol ( $X'_k[n]$ ) for said subchannel  $k$ .